5.4.4 Gravitational potential and energy

	Learning outcomes	Additional guidance
	Learners should be able to demonstrate and apply their knowledge and understanding of:	
(a)	gravitational potential at a point as the work done in bringing unit mass from infinity to the point; gravitational potential is zero at infinity	
(b)	gravitational potential $V_g = -\frac{GM}{r}$ at a distance r from a point mass M; changes in gravitational potential	
(c)	force–distance graph for a point or spherical mass; work done is area under graph	HSW5
(d)	gravitational potential energy $E = mV_g = -\frac{GMm}{r}$ at a distance r from a point mass M	
(e)	escape velocity.	HSW1, HSW2 Predicting the escape velocity of atoms from the atmosphere of planets.

(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

Lesson 5: Gravitational potential

STARTER: What is the velocity of a satellite in an orbit above the earths surface at a height of 5000km? you must seek data about the Earth.

6400+

$\frac{mv^2}{r} = \frac{GMm}{r^2}$

$v = \sqrt{\frac{GM}{r}}$

HWK (due next lesson):

Kilo 10^3 Start by equating centripetal force with gravitational force

Mega 10^6

Giga 10^9 A geostationary satellite has a mass of 80kg, calculate its KE

$V = 5900$ m/s

Key point

$$F = \frac{mv^2}{r} = \frac{GMm}{r^2}$$

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(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

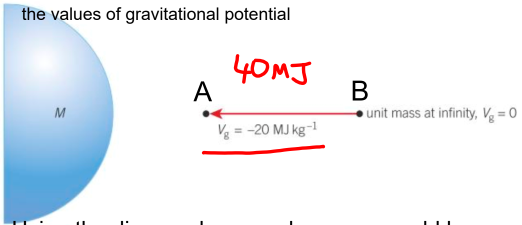
Gravitational potential

Key point

The work done in bringing a unit mass from infinity to a point in a gravitational field.

Gravitational potential is zero at infinity.

Ex: What does this definition tell us about the values of gravitational potential



Using the diagram how much energy would be required to move a 2kg mass from point A to point B?

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(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

Gravitational potential equation

Key point

$$V_g = -\frac{GM}{r}$$

Quantity		Unit
V_g	Grav Potential	Jkg^{-1}
G	Grav constant	Nm^2kg^{-2}
r	distance	m
M	Mass	kg

$V_g = -6.25 \times 10^7 \ Jkg^{-1}$

$E = 6.25 \times 10^7 \ J$

* **Example:** How much energy would it take to move 1L of water from the Earth's surface to infinty?

Ex: Scalar or vector?

Earth's radius = 6370km

Earth's mass = 5.97×10^{24}

harder example / pps / use

kerboodel example

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(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

ACTIVITY: Complete Q1 and 2 of the worksheet.

Kilo 10^3

Mega 10^6 Lowe: 9.3 p72

Giga 10^9

Key point

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(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

Plenary

Key point

The difference in gravitational potential between 2 points is 3×10^3 Jkg-1

Calculate the work done is moving a 4kg mass between the 2 points.

12×10^3 J

The gravitational potential at the Earth's surface is -6.3x107 Jkg-1

Calculate the work done is moving a 4kg mass between the 2 points

make harder...

use lowe

lowe p74 - Q6

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(6) M - Define gravitational potential
(7) S - Calculate the gravitational potential at a distance r, from a mass M.
(8) C - Calculate changes in gravitational potential

Changes in gravitational potential

Key point

$$V_g = -\frac{GM}{r}$$

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Dec 5-10:33